Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 1, Number 7; October, 2014 pp. 5-8

http://www.krishisanskriti.org/jbaer.html

Review: Analysis and Comparison of Various Techniques of Image Compression for Enhancing the Image Quality

Navneet[1], Guide[2], AP. Er. Mandeep Kaur[3]

[1,2,3]Guru Kashi University, Talwandi Saboo, Bathinda, Punjab

Abstract: **This paper focus on the area of image compression which is used in various fields of image processing. Image compression is a manner through which we can diminish the storage space of images, videos which force to increase storage and transmission process's performance. In this, we do not only concentrate on reducing size but also concentrate on doing it without losing quality and information of image. This paper presents the Comparison of two techniques Haar and db4. Image compression on basic of evaluating and analyzing both techniques. The performance of these transforms are compared in terms of Peak-signal-to-noise ratio (PSNR), Signal to noise ratio SNR, Mean squared error (MSE), Energy Retained (ER) & Execution time etc.**

1. INTRODUCTION

In this paper, we shows the comparison of the performance of Discrete cosine transform, Discrete wavelet transform and wavelets like Haar Wavelet and Daubechies Wavelet(DB4) for their implementation in a image compression system and we have also described the benefits of these transforms. The performance of all these transforms are compared with Signal to noise ratio SNR, Mean squared error (MSE) and Energy Retained (ER), PSNR etc.

Data compression is the technique which is used to reduce the redundancies in data representation in order to decrease data storage requirements and hence communication costs. Data is represented as a combination of information and redundancy. Information is an important part of data that is preserved permanently in its original form. A technique which is used to reduce the redundancy of data is defined as Data compression. Image compression is a technique in which we can easily reduce the storage space of images, videos which will helpful to increase storage and transmission process's performance. Image compression, not only reducing the size but also doing it without losing quality and information of image.

The comparison of the performance of Discrete cosine transform, Discrete wavelet transform and wavelets like Haar Wavelet and Daubechies Wavelet for implementation in a image compression system by comparing the performance of these transforms is compared in terms of Signal to noise ratio SNR, Mean squared error (MSE) and Energy Retained (ER) etc[1]. The smoothing effect which is reduced as high frequency components are added. The performance of them can be measured by calculating peak signal to noise ratio (PSNR) & Mean Square Error (MSE) [2]. On the basis of evaluating and analyzing the current image compression techniques they presented the Principal Component Analysis approach applied to image compression. It also includes various benefits of using image compression techniques [3].

2. COMPRESSION TECHNIQUES STUDIED

"2.1. Compression is a technique which is useful for removing the three basic data redundancies"

"2.1.1. Coding redundancy" is a type of the redundancy in which less than optimal code words are used.

"2.1.2. Interpixel redundancy" is a type of redundancy that gives the results from correlations between the pixels of an image.

"2.1.3. Psychovisual redundancy" is another type in which data that is ignored by the human visual system (i.e. visually non essential information).

Actually Image compression methods basically used to reduce the number of bits required to represent an image by taking advantage of these redundancies.

While an inverse process is called decompression (decoding) which is applied to the compressed data to get the reconstructed image. So the main objective of compression is to reduce the number of bits as much as possible, while to get the resolution and the visual quality of the reconstructed image as close to the original image as possible. Image compression systems are composed of two distinct structural blocks: an encoder and a decoder. There are several methods of image compression available today.

2.2. Methods of image compression

"2.2.1. Lossless compression" There is no change in the data after compression means there no loss of data. In this method each and every bit of data that was originally in the file remains after the file is uncompressed. All of the information is completely restored. Lossless compression is used only for a few applications with stringent requirements such as medical imaging.

Following techniques are included in lossless compression:

1. Run-length encoding (RLE): It is a very simple form of data compression in which *runs* of data are stored as a single data value and count, rather than as the original run. This is most useful on data that contains many such runs.

2 Huffman Encoding: This is a general technique in which statistical frequencies are occurred. The pixels in the image are treated as symbols. The symbols that occur more frequently are assigned a smaller number of bits, while the symbols that occur less frequently are assigned a relatively larger number of bits.

3. LZW Coding: LZW (Lempel- Ziv – Welch) is a dictionary based coding. Dictionary based coding can be static or dynamic. In static dictionary coding, dictionary is fixed during the encoding and decoding processes. In LZW is widely used in computer industry and is implemented as compress command on UNIX.

4. Area Coding: The algorithms for area coding try to find rectangular regions with the same characteristics. These regions are coded in a descriptive form as an element with two points and a certain structure.

2.2.2. Lossy Compression

The Lossy Compression reduces a file permanently by eliminating redundant information. Lossy methods are especially suitable for natural images such as photographs in applications where minor loss of fidelity is acceptable to achieve a substantial reduction in bit rate.
Major performance considerations of a lossy compression scheme include:
1. Compression ratio
2. Signal - to – noise ratio
3. Speed of encoding & decoding.
Lossy compression techniques includes following schemes:

1. Transformation Coding: In this coding scheme, transforms such as DFT (Discrete Fourier Transform) and DCT (Discrete Cosine Transform) are used to change the pixels in the original image into frequency domain coefficients .These coefficients have several desirable properties. The selected coefficients are considered for further quantization and entropy encoding.

2. Vector Quantization: The basic idea in this technique is to develop a dictionary of fixed-size vectors, called code vectors. A vector is usually a block of pixel values. A given image is then partitioned into non-overlapping blocks called image vectors. Then for each in the dictionary is determined and its index in the dictionary is used as the encoding of the original image vector. Thus, each image is represented by a sequence of indices that can be further entropy coded.

3. Fractal Coding: The essential idea here is to decompose the image into segments by using standard image processing techniques such as color separation, edge detection, and spectrum and texture analysis. Then each segment is looked up in a library of fractals. The library actually contains codes called iterated function system (IFS) codes, which are compact sets of numbers. This scheme is highly effective for compressing images that have good regularity and self-similarity.

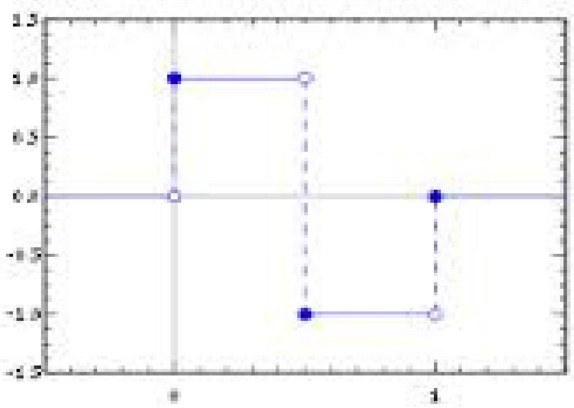
4. Block truncation coding: In this scheme, the image is divided into non overlapping blocks of pixels. For each block, threshold and reconstruction values are determined. The threshold is usually the mean of the pixel values in the block. Then a bitmap of the block is derived by replacing all pixels whose values are greater than or equal (less than) to the threshold by a 1 (0). Then for each segment (group of 1s and 0s) in the bitmap, the reconstruction value is determined. This is the average of the values of the corresponding pixels in the original block.

5. Sub band coding: In this scheme, the image is analyzed to produce the components containing frequencies in well-defined bands, the sub bands. Subsequently, quantization and coding is applied to each of the bands. The advantage of this scheme is that the quantization and coding well suited for each of the sub bands can be designed separately.

3. METHODOLOGY

3.1. Haar Wavelet

Haar wavelet is the first and simplest form of the wavelet. Haar wavelet is discontinuous, and resembles a step function. It represents the same wavelet as Daubechies db1. Hungarian mathematician Alfred Haar was the first who invented the first DWT. A list of numbers which represented an input, the Haar wavelet transform is used to simply pair up input values, storing the difference and passing the sum. This process is repeated recursively, pairing up the sums to provide the next scale, finally resulting in differences and one final sum. A simple form of compression is known as by Haar which involves averaging and differencing terms, storing detail coefficients, eliminating data, and reconstructing the matrix such that the resulting matrix is similar to the initial matrix. Wavelet analysis is similar to Fourier analysis in that it allows a target function over an interval to be represented in terms of an orthonormal function basis.



The Haar wavelet's mother wavelet function $\psi(t)$ can be described as

$$\psi(t) = \begin{cases} 1 & 0 \le t < 1/2, \\ -1 & 1/2 \le t < 1, \\ 0 & \text{otherwise.} \end{cases}$$

Its scaling function $\phi(t)$ can be described as

$$\phi(t) = \begin{cases} 1 & 0 \le t < 1, \\ 0 & \text{otherwise.} \end{cases}$$

3.2. Daubechies Wavelets (DB4)

The Daubechies wavelets, is a discrete wavelet transform and characterized by a maximal number of vanishing moments for some given support. With each wavelet type of this class, there is a scaling function which generates an orthogonal multi resolution analysis. In general the Daubechies wavelets are chosen to have the highest number of vanishing moments for given support width N=2A. There are two naming schemes in use, DN using the length or number of taps, and dbA referring to the number of vanishing moments. So DB4 and DB2 are the same wavelet transform.

4. FILTERS

4.1. Low Pass Filter

A filter that attenuates high frequencies while passing low frequencies used for blurring (smoothing).

4.2. High-pass filter

A filter that attenuates low frequencies while passing high frequencies used for sharpening.

4.3. Neighborhood-averaging filters

These replace the value of each pixel, a[i, j] say, by a weighted-average of the pixels in some neighborhood around it, i.e. a weighted sum of a[i+p, j+q], with p = -k to k, q = -k to k for some positive k; the weights are non-negative with the highest weight on the p = q = 0 term. If all the weights are equal then this is a mean filter. "linear"

4.4. Median filters

This replaces each pixel value by the median of its neighbors, i.e. the value such that 50% of the values in the neighborhood are above, and 50% are below. This can be difficult and costly to implement due to the need for sorting of the values. However, this method is generally very good at preserving edges.

4.5. Spatial filtering

is defined by
A neighborhood and
an operation that is performed on the pixels inside the neighborhood.

4.6. Gaussian Filter

In electronics and signal processing a Gaussian filter is filter whose impulse response is a Gaussian function. Gaussian filters have the properties of having no overshoot to a step function input while minimizing the rise and fall time. This behavior is closely connected to the fact that the Gaussian filter has the minimum possible group delay.

5. CONCLUSION

Our sole objective of this work comes out with the Comparison of techniques Haar and db4. Image compression is being used in order to reduce the memory required to store the images. In this paper different wavelet transforms (Haar, db4) has been used to compress the image and reconstruct the original image with different levels. Image compression on basic of evaluating and analyzing both techniques. The performance of these transforms are compared in terms of Peak-signal-to-noise ratio (PSNR), Signal to noise ratio SNR, Mean squared error (MSE), Energy Retained (ER) &

Execution time etc. From the study and analyzing the different papers we have analyze that In comparison of various transforms[1] based image compression method The DCT shows its best results in terms of energy compaction. So here it is proved that it can speed up the process but Daubechies shows better result. But in some projects haar[13] gives the better result as compared to db4 as well as at the time of zooming and denoising. Zoomed Image [2] is more sharper and less blocky. From all above observations and discussions it can be concluded that, there is necessity of the special transform which itself will give compression, will have finite integer number representation, with less entropy, having energy compaction and with less computational complexity.

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